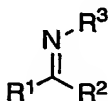
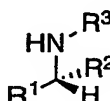


WHAT IS CLAIMED IS:

1. A process for the hydrogenation and/or asymmetric hydrogenation of an imine of Formula (I) to an amine of Formula (II):



I



II

wherein

R¹ is selected from the group consisting of aryl and heteroaryl, which two groups are optionally substituted;

10 R² is selected from the group consisting of hydrogen, aryl, heteroaryl, C₁₋₁₀alkyl, C₂₋₁₀alkenyl, C₂₋₁₀alkynyl, C₃₋₁₀cycloalkyl, C₃₋₁₀cycloalkenyl and C₃₋₁₀heterocyclo, which latter eight groups are optionally substituted; and

R³ is selected from the group consisting of optionally substituted C₁ to C₂ alkyl and optionally substituted C₃₋₁₀cycloalkyl;

15 or R¹ and R² or R² and R³ are linked to form an optionally substituted ring;

wherein the optional substituents of R¹ and R² are independently selected from one or more of the group consisting of halo, NO₂, OR⁴, NR⁴₂ and R⁴, in which R⁴ is independently selected from one or more of the group consisting of hydrogen, aryl, C₁₋₆alkyl, C₂₋₆alkenyl, C₃₋₆cycloalkyl and C₃₋₆cycloalkenyl;

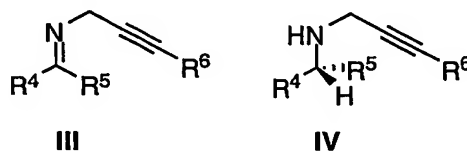
20 the optional substituents of R³ are independently selected from one or more of the group consisting of halo, NO₂, OR⁵, NR⁵₂ and R⁵, in which R⁵ is independently selected from the group consisting of C₁₋₆alkyl, C₂₋₆alkenyl and C₂₋₆alkynyl; and

one or more of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R¹, R² and/or R³ is optionally replaced with a heteroatom selected from the group consisting of

O, S, N, P and Si, which, where possible, is optionally substituted with one or more C₁₋₆alkyl groups,

said process comprising the steps of reacting imines of Formula (I) in the presence of H₂, and a catalytic system in which the catalytic system includes a base and a ruthenium complex comprising (1) a diamine and (2) a diphosphine ligand or monodentate phosphine ligands.

2. A process for the hydrogenation and/or asymmetric hydrogenation of an imine of Formula (III) to an amine of Formula (IV):



wherein

R⁴ and R⁵ represent simultaneously or independently hydrogen, aryl, heteroaryl, C₁₋₁₀alkyl, C₂₋₁₀alkenyl, C₂₋₁₀alkynyl, C₃₋₁₀cycloalkyl, C₃₋₁₀cycloalkenyl or C₃₋₁₀heterocyclo, which latter eight groups are optionally substituted, or

R⁴ and R⁵ are linked together to form an optionally substituted ring;

R⁶ is selected from the group consisting of H, aryl, C₁₋₁₀alkyl, C₂₋₁₀alkenyl, C₂₋₁₀alkynyl, C₃₋₁₀cycloalkyl and C₃₋₁₀cycloalkenyl, which latter six groups are optionally substituted;

wherein the optional substituents of R⁴, R⁵ and R⁶ are independently selected from one or more of the group consisting of halo, NO₂, OR⁷, NR⁷₂ and R⁷, in which R⁷ is independently selected from the group consisting of C₁₋₆alkyl, C₂₋₆alkenyl and C₂₋₆alkynyl; and

one or more of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R⁴, R⁵ and/or R⁶ are optionally replaced with a heteroatom selected from the group consisting of

O, S, N, P and Si, which, where possible, is optionally substituted with one or more C₁₋₆alkyl groups,

said process comprising the steps of reacting imines of Formula (III) in the presence of H₂, and a catalytic system in which the catalytic system includes a base and a ruthenium
5 complex comprising (1) a diamine and (2) a diphosphine ligand or monodentate phosphine ligands.

3. The process according to claim 1, wherein the amine of Formula (II) or its opposite enantiomer, is produced in enantiomerically enriched form.

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4. The process according to claim 2, wherein the amine of Formula (IV) or its opposite enantiomer, is produced in enantiomerically enriched form.

15

5. The process according to claim 1 or 3, wherein R¹ is optionally substituted aryl.

6. The process according to claim 5, wherein R¹ is optionally substituted phenyl,

7. The process according to claim 6, wherein R¹ is unsubstituted phenyl.

20 8. The process according to any one of claims 5-7, wherein R² is selected from the group consisting of hydrogen, aryl, C₁₋₆alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₆cycloalkyl and C₃₋₆cycloalkenyl, which latter six groups are optionally substituted.

25 9. The process according to claim 8, wherein R² is selected from the group consisting of hydrogen, aryl and C₁₋₆alkyl, which latter two groups are optionally substituted.

10. The process according to claim 9, wherein R^2 is selected from the group consisting of hydrogen, phenyl, and C_{1-6} alkyl, which latter two groups are optionally substituted.
11. The process according to claim 10, wherein R^2 is selected from the group
5 consisting of hydrogen, unsubstituted phenyl and methyl.
12. The process according to any one of claims 5-11, wherein R^3 is selected from the group consisting of optionally substituted C_1 to C_2 alkyl and optionally substituted C_3 - C_6 cycloalkyl.
- 10 13. The process according to claim 12, wherein R^3 is methyl, ethyl, i-propyl, cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl, which latter four groups are unsubstituted.
- 15 14. The process according to claims 1 or 3, wherein R^2 and R^3 , including the atoms to which they are attached, are linked to form an optionally substituted 5- or 6-membered ring.
- 20 15. The process according to claim 14, wherein R^2 and R^3 , including the atoms to which they are attached, are linked to form an unsubstituted 5- or 6-membered ring.
16. The process according to any one of claims 5-15, wherein the optional substituents for R^1 and R^2 in the compounds of Formula I, are independently selected from one or more of the group consisting of halo, NO_2 , OR^4 , NR^4_2 and R^4 , in which R^4
25 is independently selected from one or more of the group consisting of hydrogen, aryl and C_{1-4} alkyl, and the optional substituents of R^3 are independently selected from one or

more of the group consisting of halo, NO₂, OR⁵, NR⁵₂ and R⁵, in which R⁵ is independently selected from the group consisting of C₁₋₄alkyl.

17. The process according to claim 16, wherein the optional substituents for R¹ and R² in the compounds of Formula I, are independently selected from one or more of the group consisting of halo, NO₂, OH, OCH₃, NH₂, N(CH₃)₂, CH₃ and phenyl and the optional substituents of R³ are independently selected from one or more of the group consisting of halo, NO₂, OH, OCH₃, NH₂, N(CH₃)₂ and CH₃.
18. The process according to any one of claims 5-17, wherein one to three of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R¹, R² and/or R³ is optionally replaced with a heteroatom selected from the group consisting of O, S, N, NH and N-CH₃.
19. The process according to claim 18, wherein suitably one of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R¹, R² and/or R³ is optionally replaced with a heteroatom selected from the group consisting of O, S, N, NH and N-CH₃.
20. The process according to claim 2 or 4, wherein R⁴ and R⁵ represent simultaneously or independently hydrogen, aryl, C₁₋₆alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₆cycloalkyl or C₃₋₆cycloalkenyl, which latter six groups are optionally substituted.
21. The process according to claim 20, wherein R⁴ and R⁵ represent simultaneously or independently hydrogen, aryl or C₁₋₆alkyl, which latter two groups are optionally substituted.

22. The process according to claim 21, wherein R^4 and R^5 represent simultaneously or independently hydrogen, phenyl, and C_{1-6} alkyl, which latter two groups are optionally substituted.
- 5 23. The process according to claim 22, wherein R^4 and R^5 represent simultaneously or independently hydrogen, unsubstituted phenyl or methyl.
24. The process according to claim 2 or claim 4, wherein R^4 and R^5 , including the atoms to which they are attached, are linked to form an optionally substituted, suitably
10 unsubstituted, 5- or 6-membered ring.
25. The process according to any one of claims 20-24, wherein R^6 is selected from the group consisting of H, aryl, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-6} cycloalkyl and C_{3-6} cycloalkenyl, which latter six groups are optionally substituted.
15
26. The process according to claim 25, wherein R^6 is selected from the group consisting of H and C_{1-4} alkyl.
27. The process according to claim 26, wherein R^6 is H.
20
28. The process according to any one of claims 20-27, wherein the optional substituents for R^4 , R^5 and R^6 , are independently selected from one or more of the group consisting of halo, NO_2 , OR^7 , NR^7_2 and R^7 , in which R^7 is independently selected from one or more of the group consisting of C_{1-4} alkyl
25

29. The process according to claim 28, wherein the optional substituents for R^4 , R^5 and R^6 in the compounds of Formula III, are independently selected from one or more of the group consisting of halo, NO_2 , OH, OCH_3 , NH_2 , $N(CH_3)_2$ and CH_3 ,
- 5 30. The process according to any one of claims 20-29, wherein one to three, of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R^4 , R^5 and/or R^6 is optionally replaced with a heteroatom selected from the group consisting of O, S, N, NH and N- CH_3 .
- 10 31. The process according to claim 30, wherein one of the carbon atoms in the alkyl, alkenyl and/or alkynyl groups of R^4 , R^5 and/or R^6 is optionally replaced with a heteroatom selected from the group consisting of O, S, N, NH and N- CH_3 .
- 15 32. The process according to any one of claims 1 to 31, wherein said ruthenium complex has the general Formula $RuXY(PR_3)_2(NH_2-Z-NH_2)$ (III) or $RuXY(R_2P-Q-PR_2)(NH_2-Z-NH_2)$ (IV), where Z and Q represent a chiral or achiral linker; the ancilliary ligands PR_3 and $R_2P-Q-PR_2$ represent monodentate and bidentate phosphines, respectively; and the ligands X and Y represent an anionic ligand.
- 20 33. The process according to claim 32, wherein the ligand PR_3 :

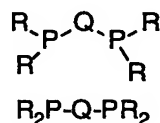


- represents a chiral or achiral monodentate phosphine ligand in which R is simultaneously
 25 or independently selected from the group consisting of optionally substituted linear and branched alkyl containing 1 to 8 carbon atoms, optionally substituted linear and

branched alkenyl containing 2 to 8 carbon atoms, optionally substituted cycloalkyl, optionally substituted aryl, OR and NR₂; or two R groups bonded to the same P atom are bonded together to form a ring having 5 to 8 atoms and including the phosphorous atom to which said R groups are bonded.

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34. The process according to claim 32, wherein the ligand R₂P-Q-PR₂:



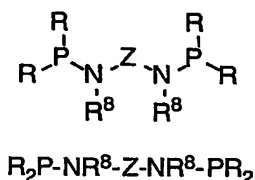
10 represents a bidentate ligand in which R is simultaneously or independently selected from the group consisting of optionally substituted linear and branched alkyl containing 1 to 8 carbon atoms, optionally substituted linear and branched alkenyl containing 2 to 8 carbon atoms, optionally substituted cycloalkyl, optionally substituted aryl, OR and NR₂; or two R groups bonded to the same P atom are bonded together to form a ring
 15 having 5 to 8 atoms and including the phosphorous atom to which said R groups are bonded; and Q is selected from the group consisting of linear and cyclic C₂-C₇ alkylene, optionally substituted metallocenediyl and optionally substituted C₆-C₂₂ arylene.

35. The process according to claim 34, wherein the ligand R₂P-Q-PR₂ is chiral and
 20 includes atropisomeric bis-tertiary phosphines, in which the two phosphorus atoms are linked by a biaryl backbone.

36. The process according to claim 35, wherein the ligand R₂P-Q-PR₂ is selected from the group consisting of BINAP, BIPHEP and BIPHEMP.

25

37. The process according to claim 32, wherein the bidentate phosphine is a chiral or achiral ligand of the type $R_2P-NR^8-Z-NR^8-PR_2$:



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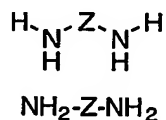
wherein each R, taken separately, is independently selected from the group consisting of optionally substituted linear and branched alkyl containing 1 to 8 carbon atoms, optionally substituted linear and branched alkenyl containing 2 to 8 carbon atoms, optionally substituted cycloalkyl, optionally substituted aryl, OR and NR_2 ; or two R groups bonded to the same P atom are bonded together to form a ring having 5 to 8 atoms and including the phosphorous atom to which said R groups are bonded; each R^8 , taken separately, is independently selected from the group consisting of hydrogen, optionally substituted linear and branched alkyl and alkenyl containing 1 to 8 carbon atoms, optionally substituted cycloalkyl, optionally substituted aryl, OR and NR_2 ; and

10 Z is optionally substituted linear and cyclic C_2-C_7 alkylene, optionally substituted metallocenediyl and optionally substituted C_6-C_{22} arylene.

20

38. The process according to claim 37, wherein the ligand $R_2P-NR^8-Z-NR^8-PR_2$ is selected from the group consisting of DPPACH and DCYPPACH.

39. The process according to any one of claims 1 to 38, wherein the diamine ligand has the Formula NH_2-Z-NH_2 :



wherein Z is selected from the group consisting of optionally substituted linear and cyclic C₂-C₇ alkylene, optionally substituted metallocenediyl and optionally substituted C₆-C₂₂ arylene.

5 40. The process according to claim 39, wherein the diamine ligand is chiral and includes (1) compounds in which at least one of the amine-bearing centers is stereogenic, (2) compounds in which both of the amine-bearing centers are stereogenic and (3) atropisomeric bis-tertiary diamines, in which the two nitrogen atoms are linked by a biaryl backbone.

10

41. The process according to claim 39, wherein the diamine ligand NH₂-Z-NH₂ is selected from the group consisting of CYDN and DPEN.

15 42. The process according to any one of claims 1 to 38, wherein the diamine is a bidentate ligand of the Formula D-Z-NHR⁹ in which Z is selected from the group consisting of optionally substituted linear and cyclic C₂-C₇ alkylene, optionally substituted metallocenediyl and optionally substituted C₆-C₂₂ arylene; D is an amido group donor or a chalcogenide radical selected from the group consisting of O, S, Se and Te; NHR⁶ is an amino group donor in which R⁹ is selected from the group consisting of
20 hydrogen, optionally substituted linear and branched alkyl and alkenyl containing 1 to 8 carbon atoms, optionally substituted cycloalkyl and optionally substituted aryl.

43. The process according to claim 42, wherein D is NR¹⁰, wherein R¹⁰ is selected from the group consisting of S(O)₂R¹⁰, P(O)(R¹⁰)₂, C(O)R¹⁰, C(O)N(R¹⁰)₂ and
25 C(S)N(R¹⁰)₂, in which R¹⁰ is independently selected from the group consisting of hydrogen, optionally substituted linear and branched alkyl and alkenyl containing 1 to 8 carbon atoms, optionally substituted cycloalkyl and optionally substituted aryl.

44. The process according to claim 42, wherein the diamine is chiral and includes (1) compounds in which the amine-bearing center is stereogenic, (2) compounds in which both the donor-bearing (D) and amine-bearing centers are stereogenic.

5

45. The process according to claim 44, wherein the diamine is $\text{CH}_3\text{C}_6\text{H}_4\text{SO}_3\text{NCHPhCHPhNH}_2$.

46. The process according to any one of claims 1 to 45, wherein the ligands X and Y is selected from the group consisting of Cl, Br, I, H, hydroxy, alkoxy and acyloxy.

10

47. The process according to any one of claims 1 to 46, wherein the base is an alcoholate or an hydroxide salt selected from the group consisting of compounds of the Formula $(\text{R}^{12}\text{O})_2\text{M}'$ and $\text{R}^{12}\text{OM}''$, in which M' is an alkaline-earth metal, M'' is an alkaline metal and R^{12} is selected from the group consisting of hydrogen, C_1 to C_6 linear and branched alkyl.

15

48. The process according to any one of claims 1-47, wherein the base is an organic non-coordinating base.

20

49. The process according to claim 48, wherein the base is selected from the group consisting of DBU, NR_3 and phosphazene.

50. The process according to any one of claims 1 to 49, wherein the hydrogenation is carried out in the absence of a solvent.

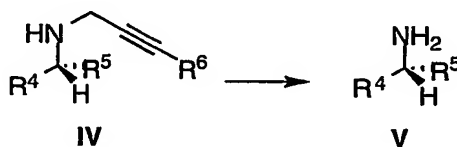
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51. The process according to any one of claims 1 to 49, wherein the hydrogenation reaction is carried out in the presence of a solvent.

52. The process according to claim 51, wherein the solvent is selected from the group consisting of benzene, toluene, xylene, hexane, cyclohexane, tetrahydrofuran, primary and secondary alcohols, and mixtures thereof.

53. The process according to claim 51, wherein the hydrogenation is carried out in an amine solvent.

54. A process for the preparation of amines of Formula V from the amine of the Formula IV, or the opposite enantiomer thereof:



wherein R⁴, R⁵ and R⁶ are as defined in any one or claims 2, 4 and 20-31, comprising reacting compounds of Formula IV under conditions for the selective removal of the CH₂-C≡C-R⁶ group.

55. The process according to claim 54, wherein the conditions for the selective removal of the CH₂-C≡C-R⁶ group comprise TiCl₃ and lithium.

56. The process according to claim 54 or 55 wherein the compound of Formula IV is enantiomerically enriched.